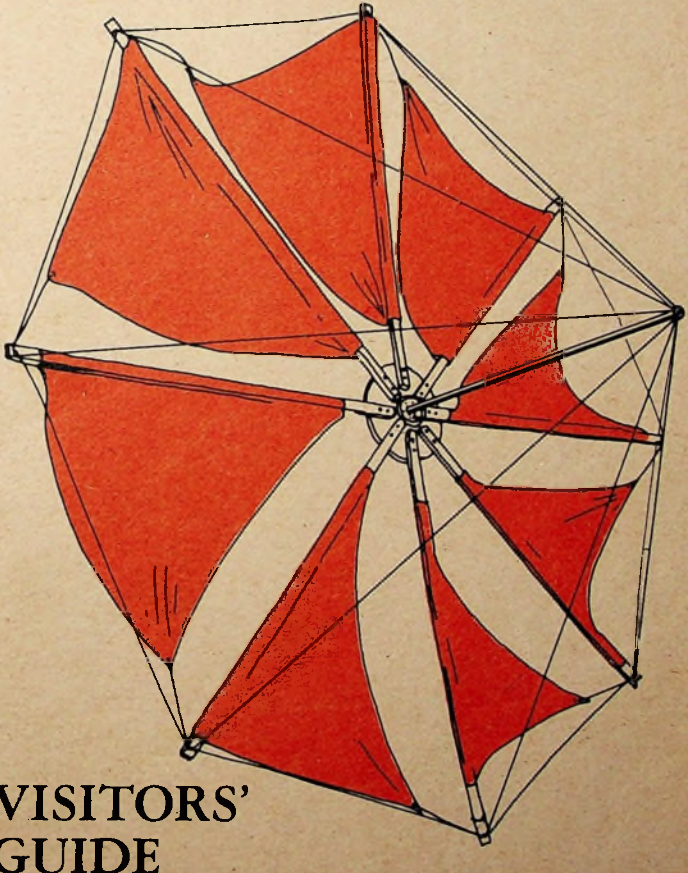
CENTRE for ALTERNATIVE TECHNOLOGY



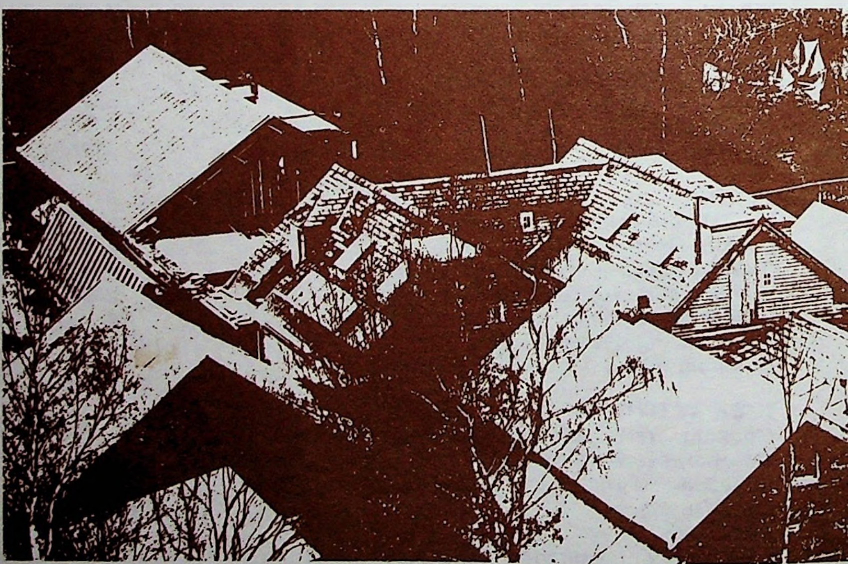
VISITORS' GUIDE

visitors guide

INTRODUCTION

The Centre for Alternative Technology was established in 1974 by the Society for Environmental Improvement, a registered charity. We are independent of direct government funding, relying on visitors to provide us with the necessary income to maintain ourselves. We aim to demonstrate ways in which we can live in balance with the natural systems and resources on which our lives depend.

We thank you for your support and welcome your suggestions for improvements to our exhibitions and working displays.



THE ALTERNATIVE TECHNOLOGY WEB

This booklet gives an indication of some of the working exhibits and demonstrations at the Centre. But to see the philosophy simply in terms of the hardware would miss the underlying reasons for our existence, which include:

- ★ **World Concern** — Its resources and people. Reducing all consumption to a level which is sustainable indefinitely and allows everyone a fair share.
- ★ **Ecology** — An awareness of man's place in the environment, and the complexities of maintaining the stability of the earth's natural systems.
- ★ **Food production** — Sustainable methods largely free of chemicals and additives; a move towards biological rather than chemical processes; improved nutrition.
- ★ **Energy** — Emphasis on conservation and renewable energy sources, with fossil fuels as a back up while these are developed.
- ★ **The Built Environment** — Approaches to energy and resource conscious design in building. Encouraging local production and variety.
- ★ **Health** — Increasing our awareness of the long term effects of modern diet, lifestyle and a heavy reliance on drugs which treat the symptom rather than cause of disease.
- ★ **Local Community** — Encouraging a wide diversity of business and social activities, with a high degree of local self-reliance and personal involvement.
- ★ **The Individual** — Effective involvement in the decisions which affect our lives — at work, at home and in the community. Valuing things like D.I.Y., voluntary work, raising families, caring for others. These are part of the 'Informal Economy' and do not appear in GNP, although this is taken by many to be a measure of progress and standard of living.

environmental concern renewable energy solar power windpower resource conservation bio-fuels wavepower hydropower clean rivers mixed farming compost small farms festivals diversity allotments fish culture tree planting hedges earthworms wildlife stability intermediate scale craftsmanship appropriate materials recycling repair do-it-yourself valuing labour low growth re-use friends of the earth balance freedom personal responsibility democracy open government practical action decentralisation local industry regional identity community demystification social audit village schools equality of opportunity participation hand tools pollution control quality simplicity adaptability durability beauty creativity vision greater self-sufficiency local politics vote green villages local shops wholeness world concern ecological perspective self-build insulation organic vegetable growing love families preventive medicine non-violence self-reliance appropriate technology honesty natural materials mental well-being nuclear mistrust long-life products low energy canals bicycles sail-ships airships railways fulfilling work cooperatives intuition low-meat diet wholefood gentleness caring sharing awareness physical activity humour sustainability small is beautiful individuality whales free range people and animals

These are some threads of the web which we call 'Alternative', or 'Appropriate' Technology.

THE VISITOR CIRCUIT

Red arrows clearly mark the path to be followed, and each exhibit has an explanatory sign next to it. This guide book is intended to supplement these signs; please refer to the list of contents on page one to locate the information you want. On the centre pages of this guide you will find a plan of the site to help you.

Quarrying stopped at Llwyngwern in 1952 and the quarry tip, on which the Centre stands, was then abandoned until 1974. In this time nature has taken a good hold and the process of natural regeneration is now well advanced. Great care has been taken to cause minimum ecological disturbance, and we therefore ask visitors to **PLEASE KEEP TO THE PATH MARKED BY THE RED ARROWS.**

By following these arrows you will be taken past all the exhibits at the Centre. Much of the equipment and techniques on display are of an experimental nature, and so, inevitably, some equipment will be out of order or under repair. In these cases you will find a notice explaining the cause, and we are sorry for any disappointment.

THE SITE COMMUNITY

We don't just display alternative technology here — we rely on it. We are not connected to mains electricity, but generate our own; we try to produce as much of our own food as possible, and to recycle our waste. In this way, we can monitor the use of alternative technology in a working environment.

There are generally about fifteen people actually living at the Centre and the remainder of the 25 staff live nearby. There are usually a number of other short term visitors who will increase over the next few years.

The balance between the requirements of a display Centre, and the private lives of those living here is very difficult to achieve. In the Wates Conservation House you will see a display of some of the **out-of-sight activities** which form part of life at the Centre. These include wine and jam making, meat curing, spinning, weaving and other crafts, and numerous other products made by the community. We also try and indicate some of the economic and social advantages of being part of a community, and aspects of group involvement in the administrative processes.

THE LECTURE HALL COMPLEX

This central building, which we designed and built ourselves, houses a **50 seat lecture hall, public restaurant and kitchen, bookshop** and **site electrical control room** on the ground floor. Upstairs is accommodation for 20 people and a residential common room.

It is insulated with 150mm (6") of Cape Rockwool insulation in the roof, 150mm Rocksill insulation in the wall cavities, and 100mm (4") of expanded polystyrene under the floor. Walls have a 300mm (1'0") thick slate waste outer skin, with 100mm thick lightweight aerated concrete blocks internally.

Internal partition walls have also been insulated to allow localised heating of smaller areas as required.

The building makes use of **'passive' solar gain** as a contribution to heating and natural daylighting through experimental **multiple layer skylights** with low heat loss.

A $10m^3$ (2000 gallon) highly insulated water **heatstore** tank situated within the building will allow for the storage of useful heat when surplus energy is available from water turbines, aerogenerators or the forge. This heat can then be used to provide part or all of the space heating requirement. One of the walls incorporates tubing in the plaster thus forming an experimental low temperature radiator surface.

RESIDENTIAL COURSES, on a wide variety of subjects, take place over winter weekends in the lecture hall building. Topics covered include **solar energy, wind power, water power, organic gardening, blacksmithing, self-building techniques and wholefood cookery.** We can also provide 'tailor made' specialist courses on some topics for schools and other institutions. For all course information please ask at the book shop for a programme and a booking form.

TRANSPORT AND SITE RAILWAY

Transport has a high environmental impact through pollution and resource consumption. At the Centre, we reduce our total transport use by living close to our place of work, and by using more efficient forms of transport. **Bicycles,** for example, are extremely energy-efficient, cause no pollution, and are just as quick as a car over short distances, especially in towns.

Electric vehicles cause minimum pollution; our **electric truck** is in regular use, has a range of 40 miles, and is charged by our water turbines. An **electric moped** is also on display in the exhibition hall.

The **Site Railway** is used for moving heavy materials by hand. Steel wheels on steel track provide a low rolling resistance. This coupled with better aerodynamics and lack of stop/start operation in traffic gives railway systems in general a considerable advantage in efficiency in terms of energy use. The whole length of track was laid by volunteers.

Factors of about 5 have been quoted for increased energy efficiency over road transport (12 million cars in the U.K. consume approx. 13 million tons — 4,160 million gallons — of petrol per year, but petroleum resources are limited and estimates show that world supplies will dry up within 30-60 years). If new lightweight railway rolling stock is developed, much road transport could be replaced by railways using a small fraction of the fuel. Over a quarter of London is already covered by roads; a two track railway can carry as many people and goods as a six-lane motorway, yet occupy only one quarter of the area of land.

PUBLIC LAVATORIES

These are largely built from slate waste and the windows demonstrate simple spanning techniques which do not use concrete, steel or wood lintels.

The building incorporates **water saving devices** in the form of dual-flush cisterns, spray and press taps, and a 'pee-can' for collecting urine. (A valuable fertiliser). Nearby are some commercial and DIY *compost toilets.* These eliminate the need for flushing water completely, require no septic tank or excavation, and can provide an odourless, high grade fertiliser for agricultural use. The operation of several compost toilets, which are in regular use by the staff at the Centre, is being monitored by the Liverpool School of Tropical Medicine.

The conventional flush toilet accounts for over one third of this country's domestic water consumption, and uses pure drinking water which is then repurified to drinking quality again. We are investigating the use of 'grey water' flushing in houses to avoid this waste.

At present the public lavatories flow into a septic tank. Until we have effected a transition to compost toilets for public use, we simply pump the sludge, once a year into our **methane digester** (see page 18). Thus a large proportion of the nutrients are returned to the land again, the natural cycle is closed and we eliminate the need for artificial fertilisers.

THE STAFF COTTAGES

Some of the staff live in these cottages which have been rebuilt from ruins, using recycled materials and volunteer labour wherever possible. They incorporate energy conserving techniques through the use of **insulation, high thermal capacity** (which reduces day/night temperature variations), **small windows** and **roof insulation** of 4" of glass fibre (0.3W/m²°C).

Please respect our privacy and do not leave the path.

In the exhibition in the Wates Conservation house you will find a comprehensive **display of insulating materials** and methods, and a wide variety of insulating techniques have been used in the buildings at the Centre.

Some of the cottages have insulation applied internally to the solid slate walls, but the furthest building has experimental **external insulation** of sprayed polyurethane foam (west wall), Rockwool under GK lath (east wall) and expanded polystyrene under weather-boarding (north wall). External insulation allows the walls to act as a large heatstore and should eliminate the problems of condensation which can occur with internal insulation. External insulation is suitable when the building is heated more or less continuously.

The cottages use either **commercial solar panels** (roof mounted) or **DIY panels** (on the ground) for hot water heating. In this situation, the DIY panels need neither pump nor temperature controller since the panels are mounted below the hot water tank and use natural thermosyphon circulation.

The solar roof on cottage 2 is 11 sq.m., and these panels can provide all of the family's hot water in the summer and make some contribution towards this in the winter. A more modest 4 sq. m. system, commercially bought and installed, is quite expensive, but could pay for itself in about 10 years.

The DIY equivalent fitted to cottage 1 is much cheaper and plans of this are available at the bookshop. Used nationally, such panels could make a very significant contribution to fuel saving.

The pump for the roof mounted panels is powered by **Silicon Solar Electric Cells.** These should not be confused with solar water heating panels. (Further details of solar systems will be found later in this guide). The pump system operates at 12v and a 30W circulating pump fed via a 4 kWh storage battery.

Cottage with sprayed external insulation and D.I.Y. solar panels

Wood or solid fuel stoves provide additional heating and the high degree of insulation calls for far smaller units than would otherwise be necessary. We hope, in due course, to provide all the back up fuel required for heating from our own programme of woodland planting.

Cottage 1, with the flat roof, has been internally insulated with Gyproc thermal board, (a combination of expanded polystyrene, vapour barrier and plasterboard).

Cottage 3, in the terrace, has been insulated internally with 75mm (3") Fibreglass wool in the walls and roof and 100mm (4") expanded polystyrene under the floor screed. Pipes laid in the floor screed are coupled to a **water tank heatstore** which can provide around 5 days heating. Energy can be fed in by electrical resistance heaters from any intermittent source such as power from a windmill or off-peak power from our water turbines.

BLACKSMITH'S FORGE AND METAL WORKSHOP

The forge demonstrates **small scale local manufacture** of many engineering components that we need at the Centre, both cheaply and without delays.

Small workshops like this can have, in a small way, far reaching effects:

a. They keep money and work in the area.
b. They help spread production more evenly over the country (decentralisation), thus reducing the pressures of urban living.
c. They enable us to prolong the life of 'obsolete' equipment and thus conserve resources.
d. They reduce our reliance on the transport system with all its environmental implications.
e. Job satisfaction is increased. Being involved with the complete process has advantages for the individual and the community.

We are able to **recycle** our own scrap metal which reduces our resource consumption. If appropriate we can now undertake casting, lathework and fabrication of most equipment that we need.

The forge is often used by volunteers about to work overseas, since it uses techniques that are suitable for developing countries. We are able to undertake some commissioned commercial work as time permits — please ask at the bookshop for details.

WATERPOWER

Another way of using renewable energy is hydro-power. The **Pelton Wheel** is one of a range of water turbines, and is particularly suited to small flow and high head (fall of water), which are the common conditions in this area. We use a 14" Pelton wheel with a flow of 140 gallons per minute and 100ft head. The water flows down a 4" pipe from a stream and a reservoir, which holds enough water to run the turbine for a week. The high pressure at the bottom of the hill forces the water through a 1" nozzle to give a high speed jet at about 50mph. The buckets are carefully shaped to convert most of the kinetic energy of the jet to mechanical power, giving an overall efficiency of about 50% and an output from the alternator of 2kW at 240V a.c.

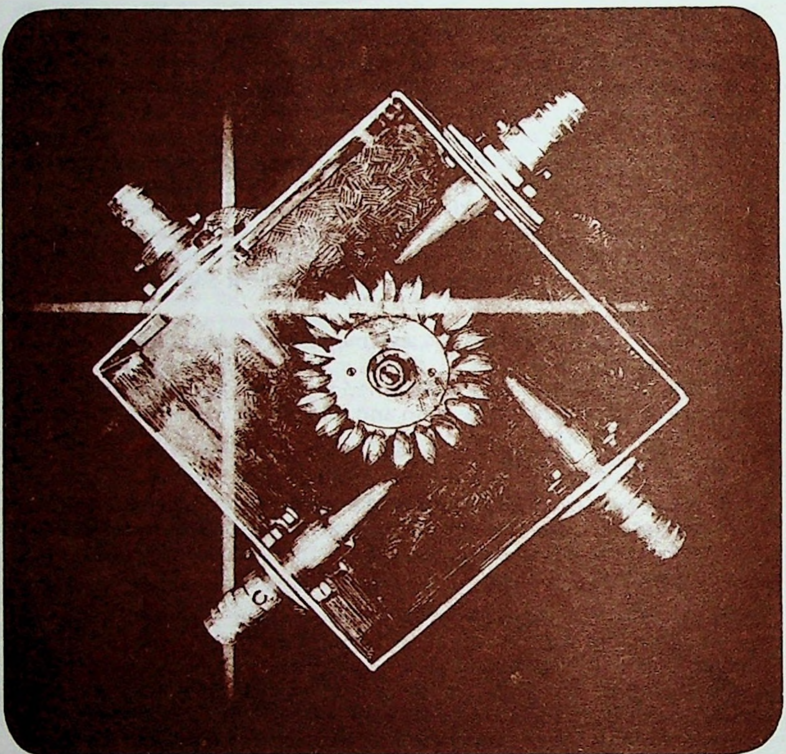
Also on display is the **IREM 400 watt miniature Pelton turbine.** This has 4 jets and the rotor directly drives a 24 volt alternator for battery charging. This Italian unit is designed for powering remote premises and can operate lights, television and a fridge, as well as making some contribution to water heating. Several other types of turbine are on display nearby.

After leaving the Pelton turbine the same water can be used for demonstration purposes on the overshot timber waterwheel or the hydraulic rams, but is usually piped to another 3kW Pelton turbine in the car park 150ft below.

Britain generates about 2% of its electricity from Hydropower. It has been estimated that we could at least treble this if we used all the potential small water power sites. Turbines are available to suit most water sources, although the initial cost may be quite high. Second-hand units can reduce this cost considerably. The Centre has carried out a survey of water power sites in the Dovey Valley, and a booklet based on this is available in the bookshop.

For small power requirements of up to a few kW's, where there is only a small head of water, a traditional steel or timber waterwheel can be an economic solution. The best of these can be around 70% efficient.

An **overshot timber waterwheel** suitable for DIY construction is installed nearby for demonstration purposes, and uses the exhaust water from the Pelton wheel. With our rather low water flow of 140 gallons per minute the wheel will develop about ¼HP at 7 rpm. With higher flow it could produce about 1HP, or even more with wider buckets. The diameter of the wheel is 10 feet, and it is constructed of timber with steel tie rofs. DIY plans are available for this wheel, but we are still experimenting with the hub, shaft and bearings.



4-jet pelton wheel turbine.

HYDRAULIC RAM

This is a **water pump** which uses no external energy supply — just flowing water in a stream. The kinetic energy of water in the drive pipe is converted to pressure energy for raising water. This principle has been used for a very long time, and there are many units operating in this country providing domestic water supply. Water can be raised up to 500ft. It is a good piece of technology, very simple and has only two moving parts. It has a very long life (about 100 years) and thus is much better than, say, an electric pump. A DIY version is available. You will see these units in the garden further round the site.

ORGANIC GARDEN

There is now a world food shortage and it will become worse. As a result food prices have risen considerably and will continue to do so. There is an increasing need for Britain to grow more of her own food; and an increasing desire by individuals to grow more themselves in their gardens and allotments. The object of the Organic Garden is to help to show people how to grow their own food with a minimum of cost and effort in a way that can maintain soil fertility indefinitely.

The principles on which the garden is run are:

1. **To improve and maintain fertility of the soil,** by increasing the organic content and by recycling nutrients using compost. All organic waste — for example, dung, urine, kitchen scraps, methane digester sludge, wood ash or weeds — can be returned to the soil in this way.
2. **To use only organic methods** and to avoid using any artificial fertilisers, weedkillers or pesticides, which are expensive both in money and resources and can be harmful to soil and health.
3. **To control pests** by rotation, cultivation methods and biological means by developing an understanding of the ecology of pests and their predators.
4. **To grow fruit and vegetables** for the Centre's requirements with a wide variety to provide an interesting diet.

An attempt has been made to demonstrate these principles. There is a display of different **compost boxes,**. materials and methods of composting, including the use of comfrey, bracken and nettles. The common **4-cycle rotation** is demonstrated and two plots show the results of different methods of organic cultivation. Displays of **biological pest control, weed ecology** and **natural fertilisers** also form part of the garden.

Greenhouses and coldframes illustrate the use of glass and polythene for growing certain crops and include examples of ways in which you can make your own. Many people start gardening on poor soil and one plot shows the results of trying to grow vegetables on reclaimed land. A wide variety of fruit and vegetables and herbs are being grown, and the whole garden has been reclaimed since 1974 from bracken covered ground and slate waste typical of this area. **Bees** are also kept for honey and to improve pollination, and there is a special bee keeping display.

You can also see some of the food producing possibilities in a typical **'suburban' garden,** and an **'urban' back yard** further round the site.

The Centre tries to buy any additional food it requires from organic market gardeners who farm nearby. In this way we hope to promote the use of locally grown produce with reduced transport costs and to encourage employment in the area.

Urban back yard

FISH CULTURE

Fish culture could make a significant contribution towards producing more of our own food, both locally and on a national scale. Land not suitable for other forms of husbandry may be used for this and thus made productive. We have experimentally run a **"closed circuit" carp culture system** at the Centre for the last three years, using solar panels to heat the water and a remote direct driving windmill to filter it. However, we found that our climate is too cold for the fish to grow rapidly, and so we have discontinued the project. This in no way invalidates the principle of fish farming, which is particularly relevant to warm third world countries. It would be possible to use a cold water fish such as trout in our climate, but these are carnivorous and require constant high protein feeding to produce fish of a commercial size.

ECOLOGICAL GARDENING

We are constructing a large pond which will be stocked with native species of plants and animals to demonstrate the principles of **"ecological gardening"**. Gardens are for pleasure as well as for growing food, but most gardens use foreign species of flowers and shrubs which do not provide a suitable habitat for our native wildlife. Behind the pond is a variety of native species of trees and shrubs, which are both attractive and valuable for wildlife.

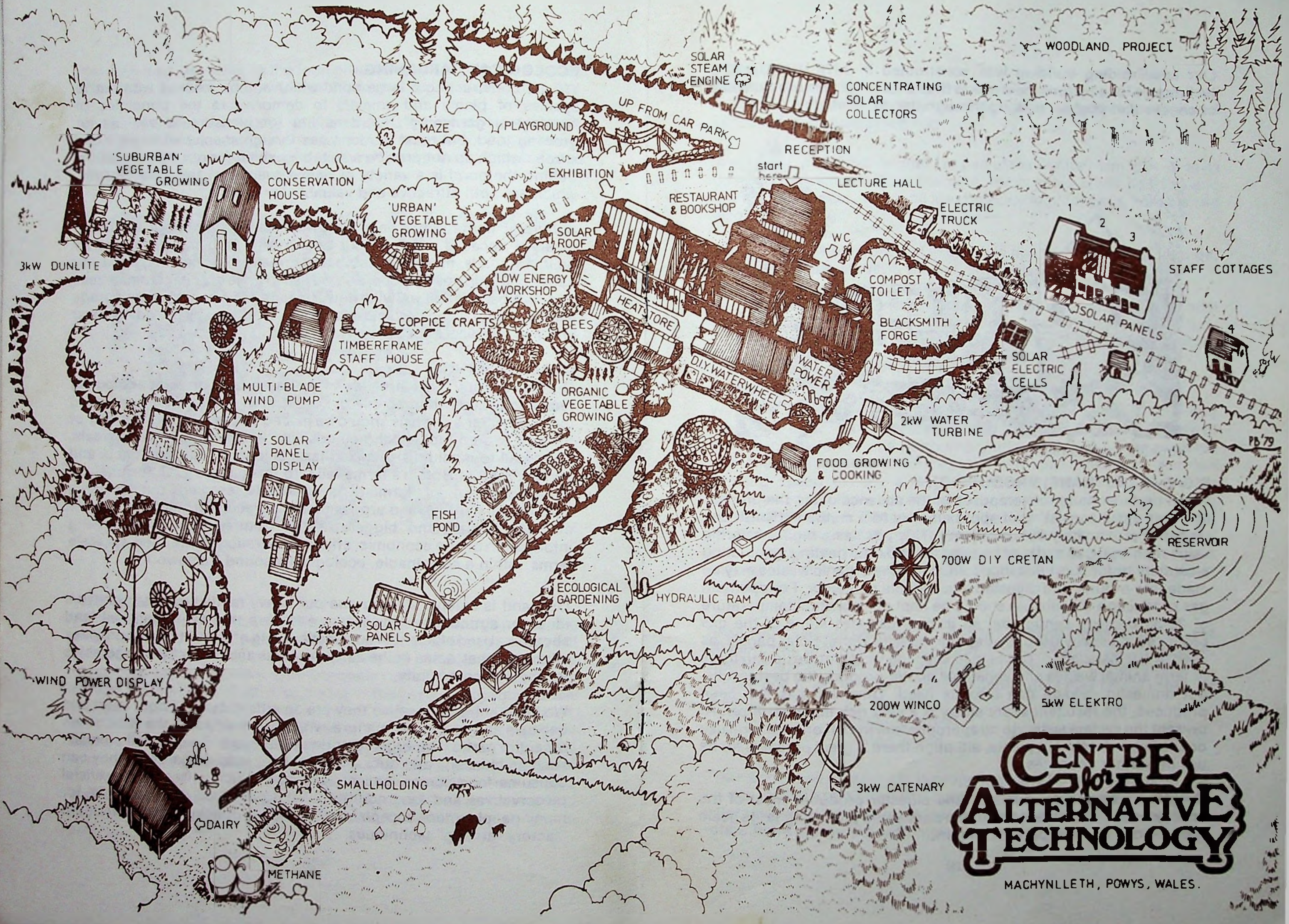
Suburban gardens are becoming increasingly important as nature reserves because much of our countryside is being destroyed by building, roads, modern farming and forestry. You can help by using native plants in your garden, and we sell a range of suitable small trees and shrubs, as well as wild flower seeds. You can also encourage wildlife by not using herbicides and pesticides, and by providing cover and nesting places for animals and birds.

SMALLHOLDING

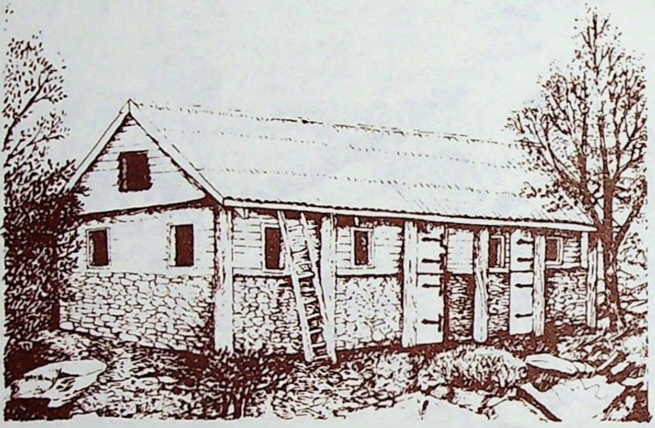
Our agricultural system needs to be based on **long term ecological reasoning** rather than simply the short term economic criteria used today. Greater emphasis should be placed on the long term fertility of the soil and on biological methods with less reliance on chemicals. The small to medium size mixed farm is ideal for this approach, and perhaps half of Britain's farms fall into this category. Unfortunately, industrialisation of farming is gradually eroding our valuable agricultural heritage and argues that to be 'economically viable' units must be bigger and bigger. At the Centre we are assembling information on the economic, efficient operation of **intermediate scale farms** within a sustainable, ecologically sound framework.

Our land is steeply sloping and our heavy rainfall makes it far from ideal for agriculture. However, we believe that even marginal land should be used efficiently; our **smallholding** of about 10 acres provides all of the meat, some of the dairy products and most of the vegetables for the site community.

We keep **animals** because they are an efficient use of poor land, and because they produce manure which is returned to the land as an essential part of the organic agricultural cycle. Some **small animals,** such as chickens and ducks, can be kept in large gardens; they can consume food scraps, and provide food which is free from artificial preservatives and food additives. Meat produced in this way is, for many people, more acceptable than that produced by some modern "factory farming" techniques.


WOODLAND PROJECT
SOLAR STEAM ENGINE
CONCENTRATING SOLAR COLLECTORS
UP FROM CAR PARK
RECEPTION
MAZE
PLAYGROUND
'SUBURBAN' VEGETABLE GROWING
CONSERVATION HOUSE
EXHIBITION
start here
LECTURE HALL
'URBAN' VEGETABLE GROWING
RESTAURANT & BOOKSHOP
ELECTRIC TRUCK
1
2
3
3kW DUNLITE
SOLAR ROOF
WC
STAFF COTTAGES
LOW ENERGY WORKSHOP
COMPOST TOILET
HEATSTORE
COPPICE CRAFTS
BEES
BLACKSMITH FORGE
SOLAR PANELS
TIMBERFRAME STAFF HOUSE
4
D.I.Y. WATERWHEEL
WATER POWER
SOLAR ELECTRIC CELLS
MULTI-BLADE WIND PUMP
ORGANIC VEGETABLE GROWING
2kW WATER TURBINE
PB'79
SOLAR PANEL DISPLAY
FOOD GROWING & COOKING
FISH POND
RESERVOIR
700W DIY CRETAN
ECOLOGICAL GARDENING
HYDRAULIC RAM
SOLAR PANELS
WIND POWER DISPLAY
200W WINCO
5kW ELEKTRO
SMALLHOLDING
3kW CATENARY
DAIRY
METHANE
CENTRE for ALTERNATIVE TECHNOLOGY
MACHYNLLETH, POWYS, WALES.

Our **smallholding building** was constructed in 1978 using simple techniques for a material cost of less than £1000. You can see a **display of cheese and yoghurt making** through the dairy window.



Smallholding building

BIO-GAS (METHANE) PRODUCTION

When organic matter decomposes in the absence of air, the process liberates a gas consisting of approximately **65% methane** (North Sea Gas is approximately 90% methane). This gas has a higher calorific value than coal gas and may be used for cooking, heating, generating electricity or for short distance transport. Any organic wastes may be made into a slurry and digested in a suitable container. For optimum gas production the mixture should be kept at a constant temperature of 30-35 degrees centigrade, so in cool climates some of the gas produced is usually used to keep the digester warm. Solar panels, as used in our installation, can help to keep the temperature up. Mixtures of farm animal wastes and vegetable matter produce the best results, but domestic sewage can also be used. Once the gas has been produced, the resultant spent slurry is a very **rich liquid fertilizer.** At present the system seems to be appropriate in the UK only for farm use or at sewage treatment plants, although there is great potential for its use in warmer countries.

Despite its small size, our methane digester produces most of the energy needs of the dairy, and there are some promising large scale installations in other parts of Britain.

FORESTRY

We are developing much of the steeper land (about 7 acres) for woodland purposes to show how trees can be grown for different purposes in an integrated way.

We plan to grow trees for **fuel,** (as part of the Centre's aim to provide its energy requirements from the site), for **coppice crafts, fencing** and **high quality timber.** They will also produce food for bees, humans and wildlife.

Trees are also being planted in the slate tips to speed up **reclamation,** since their roots stabilise the soil and resist soil erosion.

We have chosen trees which achieve these aims without the visual intrusion of single species plantations, and include sessile oak, common ash, southern beech, eucalyptus species, Japanese larch, silver birch, Scots pine, bird cherry and sycamore.

WIND POWER

We have a **variety of windmills** on the site, both **vertical axis and horizontal axis.** The power they produce depends on the swept area of the rotor, efficiency, and of course wind speed. The power available from the wind varies as the cube of the wind speed, so a small increase in wind speed causes a large increase in power. It is therefore important to site the windmill carefully for maximum wind speed and to avoid turbulence. The cube law is also the source of a major problem in windmill design: protection of the machine in high winds. The power in a 100 mph wind is 1000 times greater than that in a 10 mph wind, so a windmill must have some method of governing or shutting down in high winds.

Most windmills are designed for a range of **windspeeds from 7 mph to 30 mph,** and produce their maximum output between 23 and 30 mph. Above this speed (the **'rated wind speed'**) there is no further increase in output due to governing action. Windmill rotors may be classified by their 'tip speed ratio',

$$\frac{\text{blade tip speed}}{\text{wind speed}} = \text{tip speed ratio}$$

The slender two or three blade propellors have tip speed ratios up to 8, i.e. tip moves at 8 times wind speed, giving a high rotational speed, whereas the multiblade machines have tip speed ratios around 1 and rotate more slowly but with higher torque.

WIND MACHINES AT THE CENTRE

Horizontal Axis machines:

Cretan

This type of machine has a low tip speed ratio (approx. 0.75), has **canvas sails** and is of **simple construction** using mainly wood. It is partially self-governing by action of the sails — the changing apparent angle of wind as RPM increases causes the sails to flutter and limit RPM. Sails can be furled for protection in high winds. It can be used for **electricity generation** with speed-up drive. Our version is approx 4m (13ft) in diameter and can produce 700 watts in a 23 mph wind. A D.I.Y. sheet is available. It may also be used for **pumping or direct power take off.**

Bicycle Wheel

This is a very simple design giving up to 5 watts at 6 or 12 volts for **battery charging.** Energy output is about 1kWh per month on a good site. It is suitable for low power lighting in intermittently used buildings, powering electric fences, remote electronic equipment or keeping vehicle or boat batteries fully charged when not in use. A D.I.Y. sheet is available, which is particularly useful **for schools.** A commercial equivalent is also installed at the Centre.

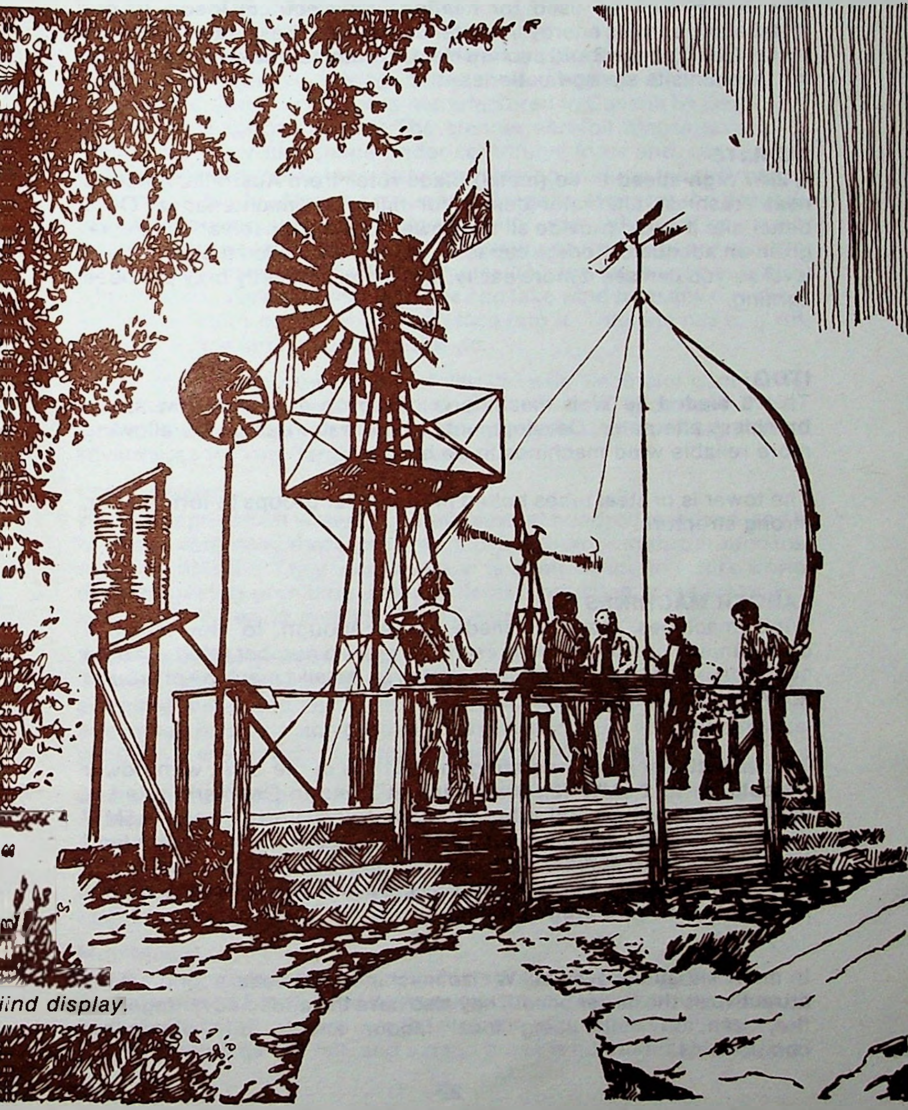
Winco

This is a **high speed** commercially available propellor type, from the United States. Maximum output is **200 Watts,** about 30kWH per month on our hilltop site. Propellor RPM is governed to about 1000 RPM maximum by a centrifugally actuated air brake.

The Winco at the top of the hill can provide **lighting** and incidental power requirements, such as radio for a small cottage. Approximately 1 week's electricity is stored in batteries to cover calm spells.

ELEKTRO

This is much larger **high-speed** rotor type with a rated output of **5kW** (approximately 400kWh per month on a good site.) It is Swiss made and has a variable pitch 5m (16ft) rotor which limits RPM above the rated wind speed and automatic shut down in high winds (the rotor is turned parallel to the wind direction). The same device is used to turn off the machine when the power is not needed.



ind display.

The energy can be used for **heating and electrical loads.** In our installation, surplus energy in winter can be stored as heat in hot water tanks. (See cottage 3 and Lecture Hall). In summer the electricity is fed to the main site storage batteries.

DUNLITE

A **2kW high-speed** three (metal) blade rotor from Australia. It uses a neat brushless alternator design for minimum maintenance. On a better site it could provide all the power for the Conservation House, given an adequate storage capacity. We have installed it on the lower level so you can see it more easily, and it consequently only provides lighting.

ITDG

This **3 bladed 50 Watt** machine is based on a modern low speed brushless alternator. Developments in alternator design are allowing more reliable wind machines to be built.

The tower is of steel tubes bolted in triangular groups to form a light, strong structure.

LARGER MACHINES

Wind machines may be made large enough to power small communities or villages. At present there are a number rated at about 100kW in operation worldwide; we hope to install a machine of around 25kW at the Centre in due course.

The largest machines operating in 1981 are in the USA, with power outputs up to 2.5MW (2,500kW) and at Tvind in Denmark; rated at 2MW. There are several other aerogenerators in the range 1.5MW under development at the moment, and the electricity from them (and in fact smaller machines) can be fed into the grid to supplement electricity generated from fossil fuels. Used in this way they do not require expensive storage systems.

In many situations even 50kW size machines can be as economically attractive as the larger ones. They also have the added advantage that they can be built using local labour and readily obtainable components.

VERTICAL AXIS MACHINES:

Darrieus Rotor or 'Catenary'

This is a new windmill design which claims a higher output for a given mass of structure — giving better material usage and economic advantages. Our machine was manufactured in Canada by Dominion Aluminium Fabrication Ltd. The slender aerofoil blades take up a natural catenary-like shape under centrifugal force and, as they are then only experiencing tension forces, they do not need the stiffness of a propellor blade. Also, by mounting the generator near the ground, tower requirements are significantly simplified. The main disadvantage is poor starting — it is usually necessary to use electric start or auxiliary rotor. The 15ft diameter DAF version is rated at **3kW** in 23mph wind. Vertical axis machines can take wind from any direction without wasting energy turning to face into it. This one has a ½ HP starting motor and produces 110V dc.

There are several other types of vertical axis electricity generating machines under development including self-starting designs. When further developed, the vertical axis approach may have significant advantages for very large machines.

WIND PUMPS:

Wind pumps can lift water from wells several hundred feet deep, and it has been estimated that there are about a million operating around the world at present. They will have a vital contribution to future world development in providing water for food production in aid areas. We have three types on display at the Centre:

Savonius Rotor (vertical axis)

This is a very simple low-speed high torque machine, ideally suited for **pumping water** and DIY construction. A DIY leaflet is available. An advantage of it, common to all vertical axis machines, is that is can take wind from any direction, without requiring a tail vane.

Sparco Wind Pump

A **two blade wind pump** of economical design for domestic or agricultural water supply. It will pump about 50 gallons per hour (max) in a 15 mph wind and is considerably cheaper than the larger multiblade pump, but it is only suitable for relatively small delivery heads.

Multiblade

An **8′0″ diameter machine** producing up to 1HP, and ideal for pumping. In a 15 mph wind it can pump about 300 gals/hour at head of 25 ft. To restrict the speed in high winds the rotor gradually turns out of the wind towards the tail, and a hand brake is automatically applied.

SOLAR ENERGY

There are four main approaches to the direct use of energy from the sun.

1. **'Passive' Solar heating.** Radiation is simply allowed into a building through windows, but careful design aims to maximise the winter 'collection' area and the amount of energy which can be stored without overheating, whilst minimising heat losses. The definition of 'Passive' techniques excludes the use of pumps and fans for moving heat around. Hybrid designs for this climate will probably use fans to reduce temperature difference, and moveable shutters for controlling heat gain and loss. Such a system, using automatically controlled insulating shutters, is incorporated into the new Light Engineering Workshop. Another example of passive solar heating at the Centre is in the Timber Frame House, described later. Such buildings generally have a very **high mass structure** which is insulated externally, and incorporate **external shading devices** to limit solar heat gain on hot summer days.

2. **'Concentrating' or 'Focussing' Collectors.** These simply concentrate direct sunlight onto a smaller collection area thus producing extremely high temperature. The energy can then be used for electricity generation, pumping, refrigeration, or hot water applications. On display at the Centre we have an array of **four Swiss sun-tracking mirrored-glass collectors.** These concentrate the sun's rays onto a black tube running down the focal line of the curved glass reflectors. The heat (at temperatures of 300° C) is conducted away, using oil. Our display shows a **small steam engine** driven by the solar heat; this is only operated on clear sunny days.

This sort of high temperature collector requires direct sunlight (unlike flat plate collectors, See 4) and is therefore more suitable for use in less cloudy climates than our own, especially for pumping operations.

3. **Solar Electric Cells**

This is currently the most expensive way of using the sun's energy, but it is appealing because the cells have no moving parts and therefore have a **long life** and need **minimum maintenance.** Electricity is produced directly from sunlight. The maximum output of the **set of** cells by the cottages is about 40 watts in the bright mid-day sun — about enough for a table lamp. The present cost of this is about £170, but manufacturers are predicting a reduction in price to about £1.00 per peak watt (£40.00 for this array) by 1990. Even now a torch battery is 50 times more expensive per Watt-hour.

The cells on display are made from mono-crystal silicon, derived from sand. The raw material is cheap and plentiful but the manufacturing process is complex and expensive. Other processes and alternative materials are being investigated in many countries.

Significant progress has been made in Japan and the USA, with the production of large areas of cells which require less energy in their manufacture. Sprayed film cells have also achieved acceptable efficiencies.

4. **Solar Water Heating panels**
This is a much simpler way of using solar energy. The panels can consist of **black absorber panels,** rather like central heating radiators, insulated on the back and covered with glass. The 'greenhouse effect' is responsible for the high temperature. The sun's radiation is short wavelength, and passes through the glass and is absorbed by the black panels. Radiation from the panels is long wavelength, which does not pass through glass, therefore heat energy is trapped. Heat is conducted away from the panels by **water** circulating through them which heats a well insulated storage tank.

SOLAR PANEL DISPLAY

A selection of different types of solar water heating panels available in Britain are on display, together with a DIY panel built at the Centre. The construction of the panels varies considerably, but the absorber plates fall into 4 main types:

Panel radiator type — either standard central heating radiator or lighter weight aluminium equivalent. These have a large surface area of water in contact with a metal absorber. (DIY Plan 4 available from bookshop).

Bonded Tube Type — a single sheet acts as the absorber. Heat is transferred by conduction to pipes bonded to the sheet at intervals and hence to the water.

Trickle Type — water runs over the absorbing surface of corrugated metal sheet and the heated water is collected in a gutter at the bottom. (Solar roof of Exhibition building and DIY plan 8). Sealing of roof space from vapour can be a problem, and although cheap this system should be used with caution.

Plastic type — various moulded or welded plastic panels are available. These have the advantage of low cost and low weight and are chemically inert. The main problem is protection against excessive temperatures, and for this reason they are not usually glazed, and therefore restricted to low temperature applications.

Efficiency tests have been carried out on a range of panels, and the results are available from the bookshop. High thermal capacity can be a disadvantage in certain conditions, where short periods of sunshine cannot be utilised because of the long heating time of the absorber plate. Most collectors are single glazed. Because of absorption in the glass, and the cost, double glazing is only considered worthwhile where particularly high temperatures can also be achieved through the use of a selective absorber surface, but at present only a few panels use this technique.

Collectors designed for **swimming pool heating** or pre-heating are often unglazed as the low operating temperatures make the benefit of glazing small; the cost of glass is better spent on more absorber area. There are two makes of swimming pool panels on display.

Precautions must be taken against **freezing in winter.** Usually the panel is designed to be self-draining or an indirect system is used which allows anti-freeze to be added to the water circulating in the absorber. Circulation is either by thermo-syphon where the panels must be mounted below the hot water tank or — more usually — by electric pump controlled by a temperature differential switch. The latter allows more flexibility in panel position and plumbing routes, the former eliminates the need for a pump, the electricity required to power it, and a differential temperature controller.

Some of the panels can be supplied in versions which form part of the roof covering, substituting for tiles, etc. Most are intended to be mounted on top of existing roofs or independently on the ground. Panels should be selected with great care, and our leaflets on Solar Energy, available from the bookshop, may prove helpful. There is now a British Standard code of practice for water heaters.

On the side of the **Timber Frame house** is mounted a **Solar Air Heater.** This is a very simple type of room heater. Cool air from the room enters the glazed box through a duct at the base of the black absorber sheet and is heated as it rises by convection. The panel provides a useful amount of heating on cold but sunny days and is cheap to construct. The house itself was built by volunteers and has 4" fibreglass insulation in the walls and double glazing.

CONSERVATION HOUSE

This building, donated by the building firm Wates Built Homes Ltd., is an attempt to demonstrate how resource consumption in the home can be reduced to a minimum, whilst maintaining a very satisfactory level of comfort. The design concentrates mainly on **energy conservation.** 450mm (18") of insulation is provided on all external walls, roof and floor, and quadruple glazing, controlled ventilation, and a heat reclaim system using a heat pump, result in very **low energy demand.** The house is thus suitable for very economic operation from the normal mains supply and also makes operation from wind power an attractive proposition in some situations, the reduced energy demand diminishing the capital investment necessary. The house uses about **one fifth** the energy of a comparable size house. Similar houses could probably be built to a price about 10% higher than a 'standard' house.

During winter periods when outside temperatures are consistently around freezing point, whole house heating is achieved with a heat input of about **1.4kW.** (We have installed a propane gas fired hot water radiator system to facilitate monitoring the building's performance).

Total space and water heating costs should average about **£1.70 per week** using natural gas or main electricity driven heat pumps.

Conservation House is an example of an approach to building which could be applied in urban and suburban areas alike. Around it we have created a suburban size vegetable garden and nearby you can see the food growing possibilities of an urban backyard. There is also a small pond designed on ecological gardening principles.

RUBBISH

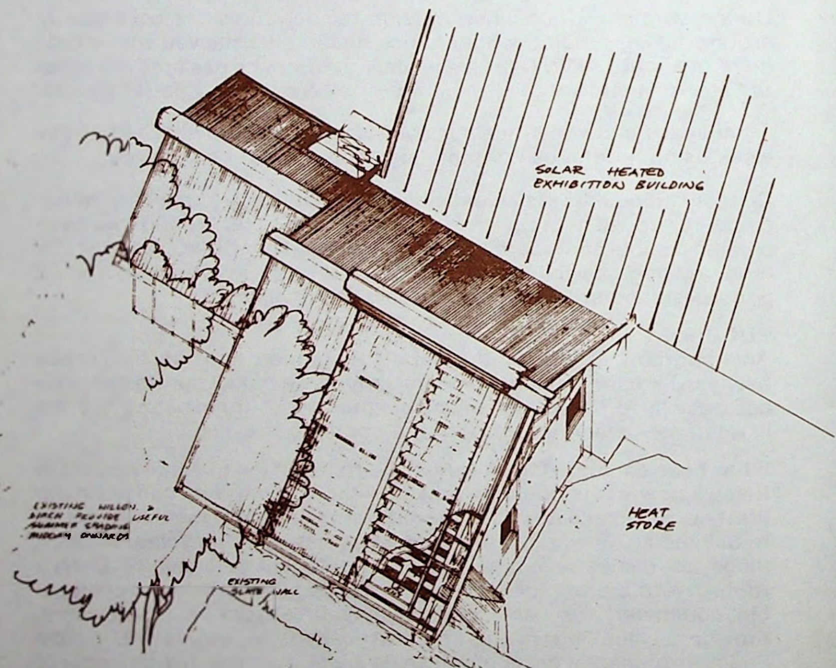
An important aspect of the suburban garden and the tiny urban backyard are the **compost bins** into which we put all our waste which has once lived. Waste is really a human concept, for in nature nothing is wasted — everything is part of a continuous cycle.

It has been estimated that at least two-thirds of the material resources that we now waste could be reused without important changes in our lifestyle. But man has broken the natural cycle, and at the Centre we try to use materials which can be **repaired, reused or recycled.** Plastics, made from valuable oil, now form a significant part of the country's rubbish and are of little use once discarded. Nonetheless a compost bin could perhaps halve the weekly refuse from an urban home, provide a valuable fertiliser and drastically reduce the plant, vehicle and environmental costs of refuse disposal. You may see a number of different recycling techniques in use at the Centre.

MAZE
Get lost in our **maze** — a light hearted introduction to the complexities of Government decision making on environmental issues.

LIGHT ENGINEERING WORKSHOP
The Rural Development Board has helped to finance a **new electronics workshop** as an experiment in establishing viable small scale manufacturing industry in a rural community setting. The workshop will commence operations during 1981 with the help of staff from the engineering department at Warwick University.

The low cost building provides 70m² of floor area but because of thorough insulation has an estimated heat requirement of less than 3kW maximum. Part of the heating will be provided by an **experimental solar roof** (see solar energy section).



Light Engineering Workshop.

EXHIBITION HALL

This building is based on the remains of the old slate cutting sheds, and was converted by staff at the Centre. The **exhibition** on the ground floor includes a **tape-slide show,** and links the various threads of alternative technology into a coherent framework. The Centre's main offices are housed upstairs.

Heating is provided by a **100m² trickle type solar roof;** hot water collected in summer is stored nearby in a **20,000 gallon underground heatstore**, and then pumped back over the winter through the floor. This system enables the building to be heated to modest temperatures all the year round, and back up heat is provided by a woodstove. Like all buildings at the Centre, the total energy demand is reduced by a high level of **thermal insulation** (in this case, 150mm thick in the roof, walls and floor).

A **multi channel recorder** monitors the performance of this and other buildings at the Centre. The results of our studies so far are published in Technical information Report no. 1, available from the bookshop.

BOOKSHOP

The tour has now returned to the main lecture hall complex. Our bookshop stocks **books** which explore the details of alternative technology in more depth, and we also sell a wide range of **leaflets and pamphlets** for people who require less detailed information. We publish a **comprehensive book-list** with notes, covering all of our own publications and most of the books that we sell. It costs 25p plus a 20p stamped addressed envelope if ordering by post. We also sell a range of **products;** all of these are in some way related to environmental concern, and wherever possible we try to stock products which are made to last and locally manufactured.

QUARRY ASSOCIATION

You can continue to support us by joining the **Quarry Association;** for a donation of at least £2.50, we will send you two copies of our newsletter, which is published twice a year. Please ask at the bookshop for details.

RESTAURANT

Our **wholefood restaurant** is open throughout the year, serving snacks, hot drinks and lunches. The food that we eat is one of the major ways that we affect the environment, and much of our modern food is unhealthy, being full of artificial additives and lacking in fibre and some important vitamins. All the food we serve is **home made,** using **fresh locally grown ingredients** wherever possible. We hope that our meals illustrate that a wholefood diet is tasty as well as being better for our health and the environment.

THE QUARRY SHOP

Our shop in Machynlleth is called the Quarry Shop and is in Maengwyn Street. From there we sell a wide range of **wholefoods;** there is a **restaurant** there too, which is open all the year round. Opening times are 9.00 till 5.30, Monday to Saturday, with early closing on Thursdays except during July and August.

THANK YOU FOR COMING

We very much hope that you have found your visit worthwhile. We also hope that you will return next year and see new additions to the Centre. The project has only been made possible by the efforts of many volunteers, low-paid staff, and other individuals as well as by the generosity of companies whose material donations have made our own limited resources stretch a comparatively long way. (A list of these companies is printed inside the back cover). The money which you gave us at the entrance will go towards the repayment of money which has been borrowed to set up the project, as well as maintenance and development and the funding of further projects aimed at improving the environment.

We welcome written enquiries about any aspect of our work — but **please enclose a stamped addressed envelope** and a small donation to cover costs.

We are also able to offer a consultancy service on architecture and engineering through our **Energy Design Group.** Please write for details.

We ask visitors to note that the demonstration or use of any device at the Centre does not in any way imply recommendation of that device, nor can the Centre be responsible in any way for the accuracy of manufacturers' claims or instructions.

HISTORICAL NOTE

SLATE QUARRYING AT LLWYNGWERN

The rise of slate quarrying in Wales coincided with the Industrial Revolution, and Llwyngwern is no exception. However, unlike the larger and more prosperous quarries nearby which follow a main seam of slate, Llwyngwern is an 'accidental' quarry. Success here depended on working a fault and hitting a vein: a hazardous business, so that the quarrying at Llwyngwern was often on the verge of bankruptcy, and the ownership changed hands many times. Quarrying finally stopped here about 25 years ago.

The slate extracted here tended to be weak, which made it unsuitable for roofing slate. Slabs were produced, particularly for tombstones, window sills and fireplaces and, in later years, for electrical switchgear. Llwyngwern slate is reputed to be in the fabric of the National Gallery.

The cutting machinery was initially powered by a 30ft water-wheel, with the water ducted from two storage reservoirs above the quarry. At the beginning of this century a steam engine superseded the water wheel, and later on diesel engines replaced steam.

The chunks of quarried slate were taken from the inner quarry to the cutting sheds on small trucks moving along a light railway laid on a slightly favourable gradient. These trucks were sometimes pulled by animals; sometimes pushed by men. Trucks similar to those used then may be seen on the newly laid railway. These came from a working mine at Blaenau Ffestiniog. Their double flanged wheels, which float on a solid axle, permit the use of tracks of varying gauge, badly laid line and track with sharp corners.

After the slate had been dressed in the cutting sheds, the resultant waste was taken on trucks along temporarily laid track and dumped. Gradually the level of waste crept further out into the valley. About 90% of the slate quarried is 'waste'.

The finished products were latterly taken along the tip to an 'inclined plane', the bed of which can be seen if you look up to the tip from the bottom of the access road. Such inclined planes were frequently used to lower slate down steep gradients, although there are now only one or two left in operation. Two parallel tracks were employed: trucks on each were connected by a rope passing round a drum (fitted with a brake) at the top of the gradient. In this way gravity was employed to lower laden trucks at the same time as empty trucks were drawn up to the top.

INDUSTRIAL AND COMMERCIAL DONORS OF MATERIALS AND EQUIPMENT UP TO AUGUST 1981

Acrow (Engineers) Ltd
Adshead Ratcliffe
Agaheat Appliances Ltd
Agfa-Gevaert Ltd
Alfa Joule Ltd
Anex Heat Pumps Ltd
Angus Fire Armour
A. Samways & Sons
Associated Health Foods
Associated Portland Cement
Automatic Pressings Ltd
Avo Ltd

Balance Engineering Ltd
Bartol Ltd
Baxenden Chemical Co Ltd
Beekey Bauknecht Ltd
Berry Wiggins & Co Ltd
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B.I.C.C. Ltd
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Chloride Industrial Batteries Ltd
Chubb Fire Security Ltd
Chubb Ltd
Concrete Masonry Group
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Granges Essem Ltd
Greenham Tool Co Ltd
Greenwood Airvac Ltd
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Hamlet Furniture Ltd
Hanway Ltd
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Henry Venables Ltd
Heywood Williams Ltd
Hoover Ltd

I.C.I. Ltd
Industrial Tank Specialities Ltd
Infil Ltd
I.T.T. Consumer Products Ltd

James Galt & Co Ltd
James Latham Ltd
James Neill (Sheffield) Ltd
John Blake Ltd
John Laing Construction Ltd
Johnson Brothers (Hanley) Ltd
Joseph Lucas Ltd
Jotul Woodburning
J. A. Crabtree & Co Ltd

Kellogg Co of G.B. Ltd
Koch-Light Laboratories Ltd
Kraft Foods Ltd
K. T. Manners Design

Lansing Bagnall Ltd
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Leyland Paint & Wallpaper Co Ltd
Lockhart Service Depot Ltd
Linread-Fabco Ltd

3M United Kingdom Ltd
Manders Paints Ltd
Matthews Wrightson Ltd
MacAlpine & Co Ltd
Mermaid Systems
Meynell Valves Ltd
M.K. Electric Ltd
Miller-Denco Ltd
Mollet Catering Equipment Ltd
Morgan-Grampian Publishers Ltd
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National Coal Board
Nestle Company
N. & T. Avery Ltd
Nuway Matting Ltd

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Pactrol Controls Ltd
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Russel & Chapple Ltd

Safari Filters Ltd
Schegel (UK) Engineering Ltd
Singleton Brothers Electronics Ltd
Sir Robert MacAlpine & Co Ltd
Smith & Wellstood Ltd
Spear & Jackson (Tools) Ltd
Staines Kitchen Equipment
Stelrad Ltd
Storey Bros. Ltd
Spray Foam Co
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Taylor Woodrow Construction Ltd
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Westland Aircraft Ltd
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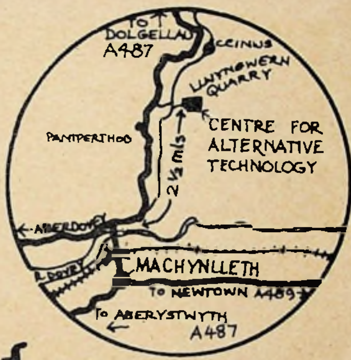

The Centre is open daily from 10.00 a.m. to 5.00 p.m., or dusk, if earlier. It is closed over Christmas.

It is situated 3 miles north of Machynlleth, just off the A487. Buses run from Machynlleth Station to Pantperthog. Coaches should approach from Machynlleth.

If you want to keep in touch with new developments, please join the Quarry Association, and receive our twice yearly newsletter.

CENTRE for ALTERNATIVE TECHNOLOGY

Llwyngwern Quarry, Machynlleth, Powys, Wales.
Machynlleth 2400.

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